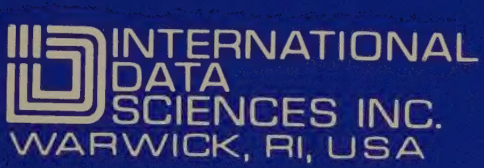

MANUAL OF OPERATION
FOR
MODEL 76B
BIT ERROR RATE TEST SET

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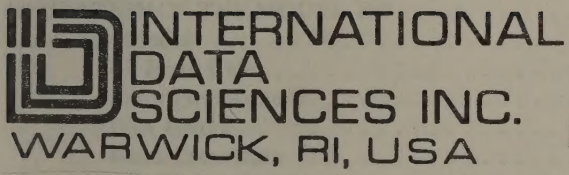

MANUAL OF OPERATION
FOR
MODEL 76B
BIT ERROR RATE TEST SET

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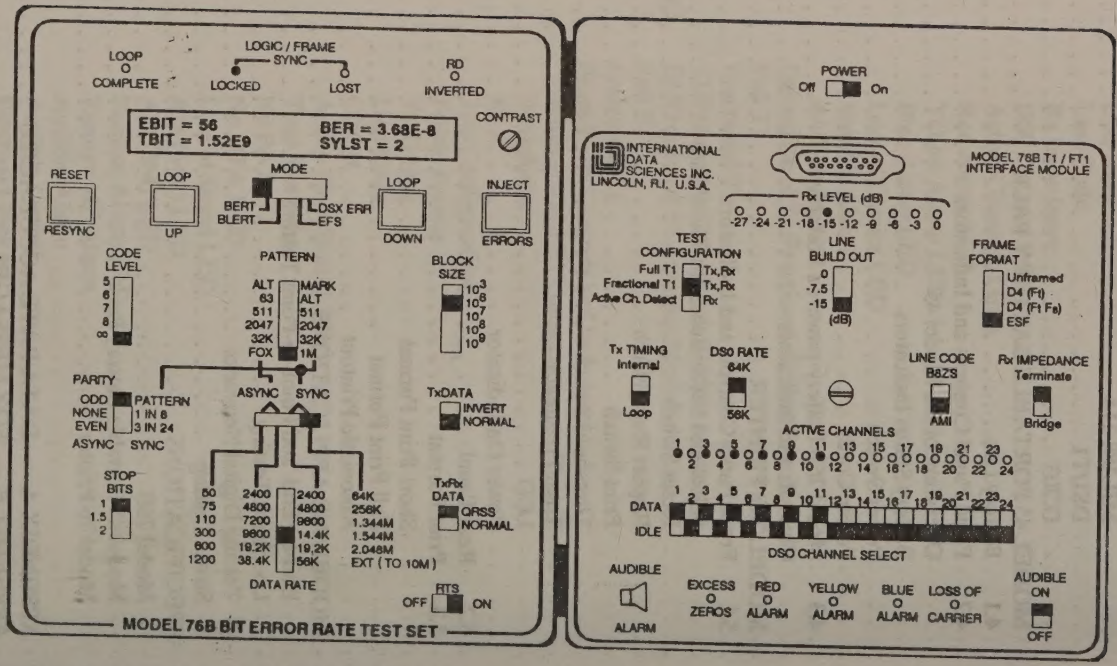


Figure 1.0 MODEL 76B WITH T1/FRACTIONAL T1 MODULE

1.0 INTRODUCTION

The Model 76B is a versatile all-purpose BERT for testing all T1, E1, Fractional T1 and E1 sync and async networks. The 76B can test networks running at data rates from 10 bps to 10,000,000 bps and features a wide variety of plug-in interface modules including: RS-232-C, DS1/T1, T1/Fractional T1, E1/Fractional E1, G.703, V.35, RS-449, MIL188-114, and EIA-530.

The Model 76B is available in the following configurations:

1) Hand-held
2) Benchtop and Rackmount
3) Battery-powered Portable

The Benchtop version of the Model 76B is identical to the Hand-held unit except that is packaged in a desk-top case and operates directly from an AC outlet. The Battery-powered Portable is identical to the Benchtop version except that it is smaller and contains an internal rechargeable battery. It too can operate from an AC outlet. A portable battery pack is also provided for the Hand-held version.

Both the Battery-powered Portable and the Benchtop versions provide storage for four interface modules. The active module is plugged into the front panel and three inactive modules are plugged into the rear panel. Figure 1.0 shows a line drawing of the Model 76B Hand-held with a T1/Fractional T1 interface module plugged into the right hand side.

The Model 76B not only performs the standard point-to-point and loop-around BERT, BLERT, and Error Free Seconds tests, but also monitors any T1 or E1 network and counts bipolar violations, framing errors, CRC errors and the number of times that sync has been lost. A unique feature of the Model 76B is its ability to transmit and receive 1 in 8 and 3 in 24 patterns to stress the T1 and Fractional T1 networks with a ones' density of 12.5%. These patterns are frame locked to the ESF and Superframe format and will not trigger yellow alarms along the network.

FEATURES

- Tests T1, E1, Fractional T1 and E1, Synchronous and Asynchronous networks
- Synchronous data rates up to 10 Mbps
- Asynchronous data rates up to 38.4 Kbps
- Measures Bit Error Rate, Block Error Rate, Error Free Seconds
- Counts Bipolar Violations, Framing Errors and CRC Errors
- Tests T1 unframed, D4 and Extended Superframe data links
- Time-Stamp and Printout all G.821 measurements

- Tests E1, Fractional E1, Unframed, CCS and CAS formats
- Tests Full and Fractional T1 and E1 circuits in full-duplex mode from a central site
- Interface Modules: T1, E1, Fractional T1, Fractional E1, V.35, RS-232-C, EIA 530, MIL188, RS-449, G.703
- 12 LEDs monitor key signals in each interface
- Hand-held with Battery Pack, Portable with built-in rechargeable battery, Benchtop, Rackmount
- Rechargeable Battery Pack provides the 76B Hand-held with up to 18 hours of continuous use

2.0 OPERATION OF THE MODEL 76B

2.1 TEST MODES OF THE MODEL 76B

The Model 76B has 4 test modes: Bit Error Rate, Error Free Seconds, DSX Errors, and Block Error Rate.

MODE 1: BIT ERROR RATE (BERT)

EBIT = 56	BER = 3.68E-8
TBIT = 1.52E9	SYLST = 2

Display shows errored bits, transmitted bits, bit error rate, and the sync lost count.

The BERT mode is used to perform a Bit Error Rate Test utilizing the selected asynchronous or synchronous pattern at the selected data rate. In this mode, the display provides the errored bits count (EBIT), the total bits count (TBIT), the bit error rate (BER), and the number of times that synchronization has been lost (SYLST).

MODE 2: ERROR FREE SECONDS

ESEC = 1	EFS = 99.8%
TSEC = 478	SYLST = 2

Display shows errored seconds, elapsed seconds, % error free seconds, and the sync lost count.

The EFS or Error-Free Seconds mode provides an error rate based on time, in blocks of 1 second, a method which effectively minimizes degradation of the overall error rate due to burst errors.The EFS measurement can be translated directly into a measurement of the percentage of time that data will be transmitted error- free over the link. The EFS mode displays the number of errored seconds, the total number of seconds the test has been running, the percentage

of error-free seconds, and the number of times that synchronization has been lost.

MODE 3: DSX ERRORS

BPV = 2	FERR = 0
EFS = 92.5%	ECRC = 1

Display shows bipolar violations, % error free seconds, and CRC errors .

The DSX ERR mode is used for monitoring a digital, bipolar network such as T1. The DSX ERR selection will only operate when a DS1/T1 or other bipolar interface module is plugged into the Model 76B. When the DS1/T1 interface is installed, the display provides the user with the number of unintentional bipolar violations (BPV), the number of framing errors (FERR), the percentage of error-free seconds with respect to the displayed errors, and the number of CRC-6 errors (ECRC) if the selected framing is extended superframe (ESF). In the event of a Loss of Carrier, Yellow, or Red Alarm, the alarm condition will be indicated on the display screen.

MODE 4: BLOCK ERROR RATE

EBLK = 1	BLER = 6.575E-4
TBLK = 1521	SYLST = 2

Display shows errored blocks, total blocks, block error rate and sync lost count.

The BLERT mode is used to perform a block error rate test. In this mode, the unit will count and display the errored blocks, total blocks, block error rate and sync lost count.

2.2 MODEL 76B CONTROLS AND INDICATORS

The following is a description of each control and indicator on the left side of the Model 76B as shown in Figure 1.0.

MODE – A four-position slide switch that selects one of the following tests to be performed: BERT, BLERT, EFS, or DSX ERR. The DSX ERR mode is used only with a digital bipolar interface such as DS1/T1 or T1/Fractional T1. If the interface attached is not compatible with the mode, the display will inform the operator.

DISPLAY – A 48-character LCD display on two lines.

CONTRAST CONTROL – Allows the user to adjust the viewing angle of the display.

LOOP COMPLETE LED (Green) – Indicates if a CSU (Channel Service Unit) has looped the data back to the test set in response to a Loop-Up code.

LOGIC/FRAME SYNC LOCKED LED (Green) – Indicates the unit is synchronized with received data when the MODE selection is either BERT, BLERT, or EFS. Indicates frame sync when mode switch is set to DSX ERR.

LOGIC/FRAME SYNC LOST LED (Red) – Is latched "on" if the receiver loses synchronization after a SYNC LOCKED condition. When in the DSX ERR MODE, this LED will be lit if frame sync was lost, at least once during testing.

Tx DATA – Allows the user to invert all transmitted data bits of a selected PATTERN. User may select either NORMAL or INVERTED transmit data. The 3 in 24 and 1 in 8 patterns are always transmitted normally, independent of the switch setting. If user attempts to invert the FOX pattern, an error message will be displayed indicating an illegal switch combination (see appendix).

RD INVERTED LED (Red) – Indicates if the incoming data pattern is inverted with respect to the Tx Data switch setting and the MODE selection is BERT, BLERT, or EFS. The status of this LED is determined during the sync detection process.

RESET/RESYNC – Resets the counters, display, receiver circuitry, and synchronization circuitry, and forces the Model 76B to re-synchronize with incoming data.

LOOP UP – Initiates the transmission of the Loop-Up code (1:4 pattern) for six seconds to activate the loop mode of a CSU (Channel Service Unit). NOTE: Loop Up/Down should not be attempted when the pattern selection is a Mark, or in an end-to-end test configuration when both test sets have the same pattern selected. This will avoid a false indication of loop complete or loop not disconnected.

LOOP DOWN – Initiates the transmission of the Loop-Down code (1:2 pattern) for an eight second interval allowing the user to deactivate the looped condition of the CSU (Channel Service Unit). NOTE: Loop Up/Down should not be attempted when the pattern selection is a Mark, or in an end-to-end test configuration when both test sets have the same pattern selected. This will avoid a false indication of loop complete or loop not disconnected.

INJECT ERRORS – A pushbutton which injects a single error each time it is pressed when the MODE selection is BERT, BLERT, or EFS.

PATTERNS – This six-position slide switch is used for selection of the data pattern to be transmitted and received by the Model 76B. The selection of a specific pattern is dependent upon whether the unit is selected for ASYNC or SYNC operation. The labels on the left side of the switch indicate the available asynchronous patterns, while the labels on the right side of the switch indicate the available synchronous patterns, when the parity switch is in the synchronous position.

This label arrangement corresponds with the ASYNC/SYNC switch setting located directly below the PATTERN switch. The asynchronous pattern selections are ALT (alternating MARK/SPACE); 63, 511, 2047, and 32K pseudo-random; and FOX. The FOX pattern can only be used with a CODE LEVEL other than ∞. The FOX message character code depends on the CODE LEVEL selection as follows:

CODE LEVEL	FOX CHARACTER CODE
5	BAUDOT
6	IPARS
7	ASCII
8	ASCII
∞	ILLEGAL

See Appendix B for the Fox Messages used.

The synchronous pattern selections are MARK; ALT (alternating MARK/SPACE); and 511, 2047, 32K, and 1M pseudo-random when the Parity switch is in the PATTERN position. If either the 1 in 8 or 3 in 24 stress pattern is selected by the Parity switch, then the PATTERN switch selection is ignored. When using DS1/T1 interface, the stress patterns are frame-locked and will not cause yellow alarms.

BLOCK SIZE – This five-position slide switch allows the user to partition the received data into blocks of data for analysis. The available block sizes are: 10^3, 10^6, 10^7, 10^8, and 10^9. The occurrence of one or more bit errors within a given block constitutes a block error. This switch is active only when the mode switch is in the BLERT position.

ASYNC/SYNC – Selects either the Asynchronous or Synchronous communications protocol.

CODE LEVEL – This five-position slide switch determines the asynchronous character code level to be used for transmitting and receiving. The selections are:

5 - Five bits per character (BAUDOT)

6 - Six bits per character (IPARS)

7 - Seven bits per character (ASCII)

8 - Eight bits per character (ASCII)

∞- No character framing.

If the FOX pattern is selected, then the FOX message will automatically be transmitted in BAUDOT, IPARS, or ASCII according to the code level setting. This switch is active only when the ASYNC/SYNC switch is set to ASYNC.

PARITY – This dual purpose three-position slide switch is used for the selection of the asynchronous character parity type to be used for async transmission. The selections are ODD, NONE, and EVEN. Although the receiver does not check for the correct parity bit, it does need to see one if a selection other than NONE is made. This switch is ignored for a CODE LEVEL of ∞. During synchronous operation, this switch allows the selection of a normal PATTERN as selected by the data PATTERN switch or a 1 in 8 or 3 in 24 stress pattern.

STOP BITS – This three-position switch is used for selecting the number of stop bits that are to be used with each transmitted character. The selections are 1, 1.5, and 2 stop bits per character. The receiver requires received characters to have a least one stop bit. This switch is ignored for a CODE LEVEL selection of ∞. This switch is active only when the ASYNC/SYNC switch is set to ASYNC.

DATA RATES (BPS) – Asynchronous: 50, 75, 110, 300, 600, 1200, 2400, 4800, 7200, 9600, 19.2K, and 38.4K. Synchronous: 2400, 4800, 9600, 14.4K, 19.2K, 56K, 64K, 256K, 1.344M, 1.544M, 2.048M, and EXT (Can be externally timed up to 10 Mbps). In Asynchronous, the selected data rate is the internal rate to be used for transmitting and receiving data. In Synchronous, the selected data rate is the rate used for transmitting data and appears as an output on TCE. If the EXT position is selected, the clock on TC is used for transmitting data, and a clock, realigned with TD, appears as an output on TCE. Appendix A lists Data Rate Accuracies.

TxRx DATA – Allows the selection of QRSS or NORMAL data during synchronous operation. When in the QRSS position, internal circuitry will allow no more than fourteen consecutive zeroes to be transmitted. The 3 in 24 and 1 in 8 patterns are always transmitted normally, independent of the switch setting. This switch is only active during synchronous operation.

RTS OFF – Allows the user to control the Request-to-Send and Data-Terminal-Ready lines of the interface as well as the transmitter output. When this switch is in the "OFF" position, the transmitted data is held to a MARK condition.

INTERFACE MODULE CONNECTOR – A 37-pin, female, D-type connector. Connects the interface module to the Model 76B test set.

LEDs – Twelve Red LEDs, six on each side of the interface module, indicate the state of the signals of each interface.

POWER – On all units that do not contain an internal battery, a two-position front-panel slide switch provides power to the unit and attached interface when in the "ON" position. On the portable unit with an internal battery, a 3-position slide switch on the rear panel has the following positions: OFF – removes power from the test set and allows the battery to charge if the AC cord is plugged into the AC wall outlet. AC – provides power to the test set from the AC wall outlet and also charges the battery. BATTERY – test set is powered from the internal battery.

3.0 MODEL 76B INTERFACE MODULES

3.1 T1/FRACTIONAL T1 INTERFACE MODULE

The T1/Fractional T1 interface module plugs into the Model 76B Bit Error Rate Test Set and provides the Model 76B with the ability to perform error rate testing on full T1 circuits as well as fractional T1 circuits. This module also allows the user to monitor an incoming T1 signal and determine which channels of the framed signal contain data and which contain idle characters.

The T1/Fractional T1 interface module provides selections for the Test Configuration, Line Build-Out, Frame Format, Tx Timing Source, DS0 Rate, Line Code, Rx Impedance, Individual Channel Content, and Audible Alarm Enable. Both contiguous and non-contiguous fractional T1 circuits can be tested at channel rates of 56 Kbps or 64 Kbps.

In the Fractional T1 mode, each of the 24 channels can be directed by the user to transmit either a Data or an Idle code. The test set then transmits the selected data pattern in each of the channels selected to contain data. The interface then transmits the framed 1.544 MHz T1 signal consisting of the selected data channels containing the test pattern and the channels containing the idle codes. The receiver performs an error rate test on the test pattern in the selected Data channels.

Twenty-four channel LEDs provide an indication of either the channels currently being used to transmit and/or receive a test pattern, or the Data/Idle status of the channels in a received framed T1 signal. Four LEDs provide a visual indication of a Red, Yellow, Blue or Loss of Carrier alarm. An audio tone occurs at half second intervals, if enabled, when an alarm is active. Ten LEDs provide a moving dot dB meter which constantly monitors the receive signal.

T1/FRACTIONAL T1 FRONT PANEL CONTROLS AND INDICATORS

Figure 3.1 is a line drawing of the front panel of the T1/Fractional T1 plug-in module.

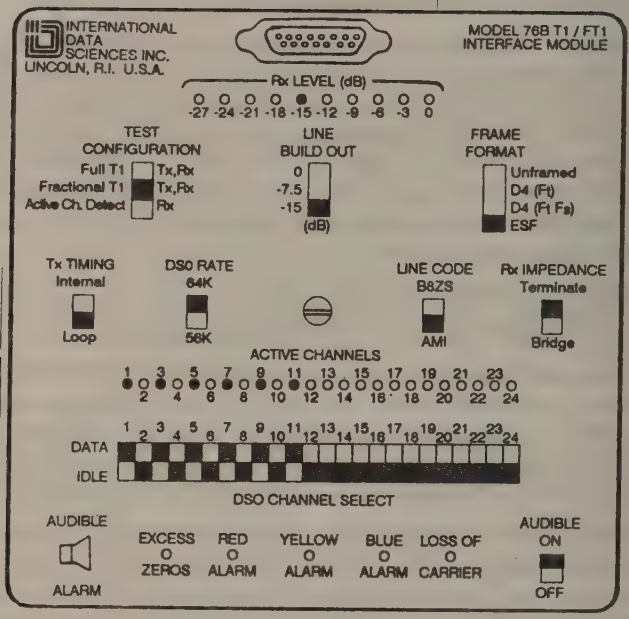


Figure 3.1 T1/FRACTIONAL T1 PLUG-IN INTERFACE MODULE

The panel is described as follows:

T1/FRACTIONAL T1 CONNECTOR – This 15-pin, female, D-type connector provides the physical interface connection to the T1 circuit. Adapters are available for connection to 310, bantam, and RJ45 jacks.

Rx LEVEL (dB) METER – Ten red LEDs from a moving dot dB meter provides a general indication of the receive level at the interface. It has a range of -17 dB to 0 dB, in 3 dB increments. The dB meter measures signal power not pulse power. Therefore, the dB readings are pattern sensitive and should be done with a mark, if possible, for the greatest accuracy. Random data will generally give a reading that is 3 to 6 dB lower. Whenever the signal level is above -27 dB, one of the LEDs will be lit. The receive signal level is at least the dB level indicated by the lit LED, but less than the next higher level or more positive LED value (the LED to the right of the LED which is on).

TEST CONFIGURATION –This three-position slide switch allows the user to transmit and receive/analyze a Full T1 signal, a Fractional T1 signal with user-selectable data channels, or in the Active Channel Detect position, to

automatically detect which received T1 channels contain data and which contain idle characters.

LINE BUILD-OUT – This three-position slide switch allows the selection of three levels of line build-out: 0 dB, -7.5 dB and -15 dB. The -7.5 dB and the -15 dB positions provide output signals which are equivalent to the output of cables having 7.5 dB and 15 dB losses, respectively.

FRAME FORMAT – This four-position slide switch allows the selection of either unframed data, D4 (with F_t bits only) framing format, D4 (with both F_t and F_s bits) framing format or Extended Superframe (ESF) format. In the Unframed mode, data is transmitted as a continuous bit stream without the addition of framing bits. In the framed modes, a bit pattern embedded within the data stream structures the channelized data for proper retrieval.

The D4 (F_t) selection provides a modified D4 type framing. The terminal framing (F_t) bits are added to the transmitted data stream, but the signal framing (F_s) bits are not. The receiver checks the F_t bits to establish frame sync and ignores the F_s bit positions which are used as data bit positions. This type of framing is used in network applications which do not require signaling but use the additional bandwidth for data transmission such as SLC-96*. (SLC-96 is a registered trademark of AT&T)

The D4 (F_t, F_s) selection provides data which is formatted with conventional D4 framing, utilizing six terminal framing bits (F_t) and six signal framing bits (F_s) to qualify and maintain frame synchronization. The F_s bits identify the frames containing signaling information. This framing type consists of twelve 193-bit frames combined to form a Superframe.

The ESF selection provides framing which consists of twenty-four 193-bit frames combined to form an Extended Superframe (Fe). ESF uses only six framing bits which perform the functions of both the F_t and F_s bits of D4. Six additional bits are used for CRC or error checking and twelve bits are available for a data link. When testing an ESF signal, the CRC is monitored for errors and the data link bits will contain test pattern bits.

Tx TIMING – This two-position slide switch allows the transmit timing source to be selectable between either the INTERNAL 1.544 MHZ crystal oscillator or the recovered clock (LOOP). In systems slaved to a central timing source, the user must select LOOP TIMING or timing slips will cause errors and sync losses. If a central timing source is not used, then a selection of INTERNAL is necessary. The LOOP selection causes the recovered receive clock to be passed through a jitter attenuator to reduce any jitter produced by the pulsed-tank circuit clock recovery of the interface module receiver. The de-jittered clock is used as the timing source for the test set's transmit data.

DS0 RATE – This two-position slide switch allows the user to choose an effective channel rate of either 56K or 64K, depending upon the network requirement. When 64K is selected, all eight bits of a data channel contain pattern data, providing clear channel capability. When 56K is selected, only seven bits in each active channel contain data. The eighth bit is always a one.

LINE CODE – This two-position slide switch determines the line code to be used by the module. Basically, the two selections provide the choice between utilizing zero suppression or not. If the system uses AMI and the test set has B8ZS selected, the test set will transmit BPVs which may upset network equipment. If the system used B8ZS and the test set has AMI selected, excess zeroes may be transmitted and the intentional bipolar violations will be counted by the test set.

In the B8ZS position, the interface uses the B8ZS (Bipolar with 8 Zero Substitution) method of zero suppression which provides Clear Channel Capability as per the AT&T Compatibility Bulletin 144, Issue 1, April 1981. When B8ZS is selected, the interface transmitter replaces any 8 consecutive zeros in the transmit data supplied by the base unit with a B8ZS code word (11011000). This code word is transmitted with intentional bipolar violations at bit 4 and bit 7 to distinguish it from ordinary data. The interface receiver recognizes the code word to 8 zeros before passing it to the base unit.

Although bipolar violations occur when B8ZS is used, the interface does not recognize them as valid and does not inform the base unit of intentional bipolar violations. Thus, intentional bipolar violations are not counted by the Model 76B when B8ZS is selected. The AMI selection provides the standard Alternate Mark Inversion without zero suppression. It should be noted that if AMI is selected, zero suppression will effectively occur when a DS0 Rate of 56K is selected because the eighth bit of every channel is forced to a one.

Rx IMPEDANCE – This two-position slide switch changes the input impedance of the receiver. In the TERMINATE position the receiver input impedance is 100 ohms. This position is used when the test set is terminating the link. The BRIDGE position increases the receiver input impedance to 1K ohms. This position is used for passive monitoring of a network.

DS0 CHANNEL SELECT– Twenty-four dip switches labeled DS0 CHANNEL SELECT are used in the Fractional T1 test configuration to select which channels are to contain the test pattern data and which are to contain idle characters for transmission within the T1 frame. The receiver will only look at the channels selected as DATA for analysis of the received data. Each channel switch is numbered according to its respective channel position within the frame. Each switch has two selectable positions labeled DATA and IDLE. When a channel select switch is "on" (DATA position), the appropriate active channel LED will light and 7 or 8 bits of the selected transmit data pattern,

depending upon the DS0 Rate selection, are placed in that channel of each frame. When a switch is "off" (IDLE), the LED associated with that channel will be "off," and an idle code of 7FH will be transmitted in that channel of each frame.

ACTIVE CHANNELS LEDs – Twenty-four green LEDs labeled ACTIVE CHANNELS are provided to inform the user which channels of the frame contain data and which contain idle codes. When the Active Channel Detect test configuration is selected, the receiver will examine each channel for repetitive data. If the data within a channel is repetitive, the test set assumes the presence of an idle code and turns "off" the LED associated with that channel. If the channel data is non-repetitive, the test set assumes the presence of true data and turns "on" the LED associated with that channel.

In the Fractional T1 test configuration, each channel LED will indicate whether its respective DS0 Channel Select switch is in the DATA position (LED "on") or in the IDLE position (LED "off"). In the Full T1 test configuration, all of the Active Channel LEDs will be "on," indicating that all channels are being used for the selected test pattern. If unframed data is selected when the test configuration is either Fractional T1 or Active Channel Detect, the active channel LEDs will flash at a one second rate to tell the user to select a framed format.

RED ALARM LED – Whenever the interface has a framing format other than Unframed selected, it will check the incoming data for frame synchronization by comparing the expected framing pattern with the data stream. Once verified, the unit is in FRAME SYNC. The framing pattern is continuously monitored for frame bit errors after achieving sync. The RED ALARM LED is turned "on" if 2 out of 5 of the F bits are in error. The Audible Alarm will also sound, if enabled. When in the Full or Fractional T1 test configurations, the Model 76B will also display the message: RED ALARM, LOST LOCAL FRAME SYNC.

YELLOW ALARM LED – A YELLOW ALARM is a specific, frame-type dependent bit pattern which is transmitted by network equipment in response to their receiver losing frame synchronization (RED ALARM detection). In the D4 (F_t) and D4 (F_t, T_s) framing formats, a yellow alarm is declared if bit 2 of all channels is a 0 for 256 or more consecutive channels.

In the ESF format, yellow alarm is declared if a repeating pattern of 00FFH is detected for sixteen repetitions. The Model 76B T1/Fractional T1 Interface Module continuously monitors the incoming data stream for a YELLOW ALARM signal. If the YELLOW ALARM pattern is detected, the YELLOW ALARM LED is turned "on" and the Audible Alarm will sound, if enabled. The Model 76B will display the following message if the interface is not in the Auto

Channel Detect configuration: YELLOW ALARM, LOST REMOTE FRAME SYNC.

BLUE ALARM LED – The Model 76B T1/Fractional T1 Interface Module monitors the incoming data stream for an AIS (Alarm Indication Signal). A Blue Alarm is declared whenever 2 consecutive frames contain less than 3 zeros within the channel data. Upon detection, the BLUE ALARM LED is turned "on" and Audible Alarm will sound, if enabled. A Blue Alarm indicates that a transmission fault has occurred upstream. It is transmitted by the one detecting the fault in order to maintain network timing integrity. No message is displayed on the Model 76B.

LOSS OF CARRIER LED – The Model 76B T1/Fractional T1 Interface Module continuously monitors the receive signal for data activity. If the receiver detects thirty-two consecutive zeros, the LOSS OF CARRIER LED is turned "on" and the Audible Alarm will sound, if enabled. A Loss of Carrier alarm takes precedence over the other alarms by the base unit. Therefore, even though a Red Alarm LED may also be "on," the Model 76B will display "LOSS OF CARRIER" on its LCD. Note: The Model 76B will not display any error message when in the Auto Channel Detect configuration.

AUDIBLE ALARM – When enabled by the AUDIBLE On/Off switch, this speaker generates an audible tone whenever a RED, YELLOW, BLUE or LOSS OF CARRIER ALARM is detected. The tone will turn "on" and "off" at a one second rate and will continue as long as any alarm condition exists.

AUDIBLE ON/OFF – This two-position slide switch enables or disables the Audible Alarm.

OPERATION OF THE T1/FRACTIONAL T1 INTERFACE MODULE

The T1/Fractional T1 (T1/FT1) Interface Module for the Model 76B provides the physical interface to the network via a 15-pin, female, D connector. Adapters are available for 15-pin to 310 plugs, 15-pin to bantam plugs, and 15-pin to RJ45 connectors. This interface is capable of testing full or fractional T1 networks, and providing the means to select a variety of T1 format variables such as FRAME FORMAT, LINE CODE, amount of LINE BUILD-OUT, the effective channel rate (DS0 RATE), the Tx TIMING source and the IMPEDANCE.

The proper switch selections must be made in any of the test configuration modes in order to match the T1/Fractional T1 Interface Mode parameters to the parameters of the T1 network under test. The only restriction is that the Unframed format cannot be selected when the test configuration is either Fractional T1 or Active Channel Detect. These modes require channelization

which is only possible in a framed T1 signal. If Unframed is selected in either of these modes, the 24 Active Channel LEDs will flash at a one second rate to indicate to the user to select a frame format.

At power-up the unit will turn the 24 channel LEDs, the 4 alarm LEDs and the audio (if enabled) "on" for approximately 4 seconds. The interface module's program memory is tested during this time. If there is program memory failure, the 4 alarm LEDs will flash and the audio (if enabled) will sound.

The interface module is internally reset whenever an interface switch is changed, however, the Model 76B should also be reset anytime an interface switch has been changed in order to avoid the display of erroneous data.

In order to perform a LOOP UP via the Model 76B, the user must place the interface in the Full T1 configuration prior to initiating LOOP UP. Once the loop has been completed, the test configuration may be changed for testing factional T1 circuits.

The Model 76B must have a pattern selection other than Mark, and the interface must be selected for Full T1 prior to initiating a LOOP DOWN. Once the loop has been disconnected, the test configuration may be changed. NOTE: If two test sets are set up in a full duplex arrangement and either a LOOP UP or LOOP DOWN is performed, the results will be erroneous if they both have the same pattern selected. This is because the Model 76B does not have the ability to look at the loop pattern bit for bit. It only looks for synchronization of the selected pseudo-random pattern after the loop pattern has been transmitted for its specified time. If the patterns are the same, it may think it has looped up when it has not, or that it has not looped down when it actually has.

The 1 in 8 and the 3 in 24 pattern selections on the Model 76B are intended to be used to stress the network by placing the maximum number of allowable zeros in the data field. In order to utilize the patterns effectively, they should only be used when the DS0 Rate is 64K. At this time, the true channelized 1 in 8 or 3 in 24 test pattern is transmitted. If the DS0 Rate selection is 56K, only 7 bits of the pattern will be placed in a channel because bit 8 is forced to a one. The intended eighth pattern bit is placed in the next data channel, thus shifting the stress pattern. The stress patterns will still achieve synchronization and not trigger alarms when operating with 56K channels, however, they will not align on a channel basis and will not stress the network because it is already limited to a maximum of 7 zeros by the DS0 selection.

FULL T1

The Full T1 test configuration allows the user to test either framed or unframed T1 signals which utilize the full bandwidth available for data transmission. For unframed T1, this means a full 1.544 MHz bandwidth for data. For framed T1 with 64K channels, all 24 channels are used for data transmission providing an

effective bandwidth of 1.536 Mhz for data and a bandwidth of 8 kHz for framing. For framed T1 with 56K channels, the bandwidth is 1.344 MHz for data, 8 kHz for framing and 192 kHz for the eighth bit of every channel being a "one."

When the Full T1 test configuration is selected, the 24 Active Channel LEDs light, indicating that the test pattern selected on the base unit will be transmitted and received in all 24 channels of every frame. The user must select the proper Frame Format, Line Build-Out, Tx Timing source, DS0 Rate, Line Code and Receiver Termination.

The base unit (Model 76B) allows the user to perform either a Bit Error Rate, Block Error Rate, or an Error Free Seconds test utilizing either a selectable fixed or pseudo-random pattern. The Model 76B can also provide counts of bipolar violations, framing errors and CRC errors in its DSX ERR Mode. Alarm conditions are reported by LEDs on the module. Loss of Carrier, Red Alarm, and Yellow Alarm messages are displayed on the LCD of the base unit. An audible alarm can be enabled to indicate an alarm condition. A ten LED level meter located just below the 15-Pin D connector provides a general indication of the received signal power.

FRACTIONAL T1

The Fractional T1 test configuration allows the user to make the same selections as Full T1, except that the Frame Format must not be Unframed. With Fractional T1, the bandwidth available for user data is determined by the number of 56 or 64 kHz channels leased. The channels containing data must contain an idle code. If a user has leased a one quarter T1 link and used 64 kHz channels, 6 channels (24 divided by 4) would be available and the effective bandwidth would be 384 kHz (64K times 6). If 56 kHz channels are used, the effective bandwidth for data would be 336 kHz (56K times 6). Data channels may be either contiguous or non-contiguous.

Contiguous channels are a group of consecutive channels utilized for data transmission, such as channels 1, 2, 3, 4, 5 and 6. This Fractional T1 channelization requires the user to adhere to minimum pulse density requirements. This can be achieved by using either 56 kHz channels in which bit 8 of each channel is a 1 or by using 64 kHz channels with B8ZS Clear Channel Capability.

Non-contiguous channels are alternate channels in a frame, such as 1, 3, 5, 7, 9 and 11. They are required when operating with an AMI line code and 64 kHz channels in order to ensure a minimum pulse density. This is maintained by having an idle character in every other channel.

When in the Fractional T1 configuration, 24 dip switches allow the user to select which channels will contain data and which channels will contain a 7FH idle code within a transmitted frame. The same channels selected as DATA are analyzed by the receiver for the selected test patterns. The 24 Active Channel

LEDs provide a visual display of the channel switch selections where the respective channel LED is "on" for DATA and "off" for an IDLE code.

The pattern selected by the base unit is transmitted serially in the selected DATA channels and a 7FH IDLE code is transmitted in each of the other channels. The receiver drops the selected DATA channels from the received frames and sends the data to the base unit for pattern analysis at the effective bandwidth rate. The overall T1 frame is analyzed by the interface for alarm conditions and T1 associated errors.

In non-contiguous T1, the data may come back with one or more channels delayed due to different routing paths through the network. If this occurs, the Model 76B will not sync up with a pseudo-random pattern selected. However it will sync up with a Mark when the DS0 Rate is 56K or a Mark, Alternate or a 1 in 8 pattern when the DS0 Rate is 64K. This is because these patterns are repetitive on a channel basis and will be consistent regardless of any delayed channels. In order to test non-contiguous with a pseudo-random pattern, the user would have to perform the test on each individual channel.

ACTIVE CHANNEL DETECT – The Active Channel Detect test configuration selection provides the user with the ability to determine which channels of a Fractional T1 link are being utilized for data transmission and which channels are idle. The same Full T1 setup selections are allowed except the signal must be framed. In the Active Channel Detect configuration, the Receiver monitors each channel of a framed T1 signal for either changing data or repetitive data.

The twenty-four channel LEDs will inform the user of channel content. If a channel contains variable data, its respective LED will be "on." If a channel contains a repetitive byte, it is considered idle and the respective LED will be "off." The interface transmitter continuously transmits idle characters in each channel while in this mode, and if looped back to its receiver, all of the channel LEDs would be "off."

T1/FRACTIONAL T1 (T1/FT1) INTERFACE MODULE SUMMARY

Interface Specification	AT&T Pub. 62411, CB144, Issue 1
Framing Format	Unframed, D4 (F_t), D4 (F_t, F_s), ESF
Line Code	AMI or B8ZS
Tx Timing	Internal 1.544 MHz, Loop (recovered receive clock)
Rx Impedance	Terminate (100 ohms), Bridge (> 1K ohms)
Test Configuration	Full T1, Fractional T1, Active Channel Detect
Channel Rate	56 kHz, 64 kHz
Line Build-out	0 dB, -7.5 dB, -15 dB

Rx Level Meter	Ten red LEDs
Alarm LEDs	RED (red LED), YELLOW (yellow LED), BLUE (red LED), LOSS OF CARRIER (yellow LED)
Active Channel LEDs	Twenty-four green LEDs indicate which of the 24 channels contain data or idle characters
DS0 Channel Select	Twenty-four dip switches select the channel contents (Data or Idle)
Audible Alarm	Sounds on alarm conditions, memory failure, illegal settings. Disable with ON/OFF switch
Speed	1.544 Mbps
Interface Connector	25 pin, male, D-type. Cable included

3.2 E1/FRACTIONAL E1 INTERFACE MODULE

Figure 3.2 is a line drawing of the E1/Fractional E1 Interface Module.

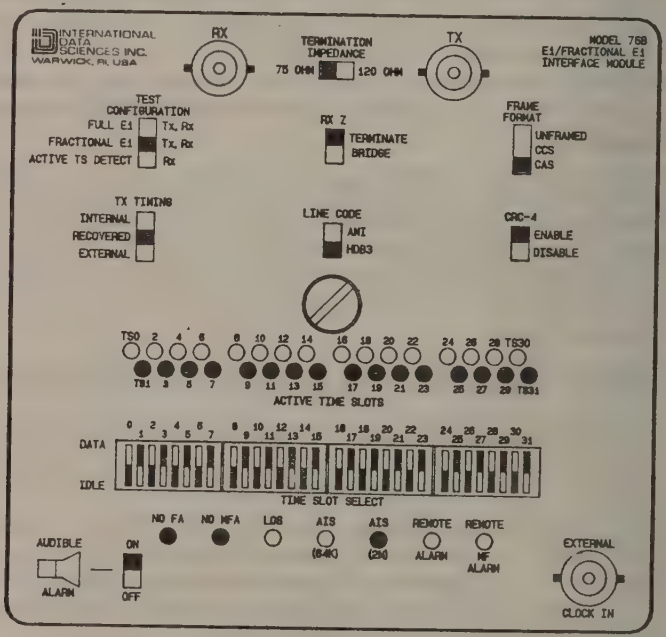


Figure 3.2 E1/FRACTIONAL E1 INTERFACE MODULE

The E1/Fractional E1 Interface Module for the Model 76B provides the physical interface to the network via BNC connectors. This interface, capable of

testing full or fractional E1 networks, provides flexibility in selecting E1 format variables. These are Frame Format, CRC-4, Line Code, the Tx Timing source, and Impedance.

The proper switch selections must be made in order to match the E1/Fractional E1 Interface Module parameters to the parameters of the E1 network under test. The only restriction is that the Unframed format cannot be selected when the Test Configuration is either Fractional E1 or Active TS Detect because framing is required for defined time slots to exist.

If Unframed is selected in either of these modes, the 32 Active Time Slot LEDs will flash at a one second rate and the audio alarm will sound, if enabled, until the setup error is corrected.

At power-up, the unit will turn the 32 time slot LEDs, the 7 fault LEDs, and the audio (if enabled) "on" for approximately 4 seconds. The interface module's program memory is tested during this time. If there is a program memory failure, the 7 fault LEDs will flash and the audio will sound. The interface module is internally reset whenever an interface switch is changed. In order to avoid the display of erroneous data, the Model 76B should also be Reset anytime an interface switch has been changed

FULL E1

The Full E1 Test Configuration allows the user to test either framed or unframed E1 signals which utilize the full bandwidth available for data transmission. When the Full E1 test configuration is selected, and the Frame Format selection is Unframed, all of the Active Time Slot LEDs will be lit, indicating that the entire bandwidth is being utilized for data transmission.

When the Frame Format selection is CCS, the TS0 LED is "off," indicating that it contains the frame alignment signal, and the TS1-TS31 LEDs will be "on," indicating that data is to be transmitted and received in those channels.

When the Frame Format selection is CAS, TS0 and TS16 LEDs are "off" because they contain the frame and multi-frame alignment signals, respectively, and the Active Time Slot LEDs for TS1-TS15 and TS17-TS31 are "on" because they are available for data transmission.

The user must select the proper Frame Format, Tx Timing source, Line Code, impedance and Receiver Termination. The base unit allows the user to perform either a Bit Error Rate, Block Error Rate, or an Error Free Seconds test utilizing either a fixed or pseudo-random pattern. It can also provide counts of bipolar violations, framing errors, and CRC errors. Alarm and fault conditions are reported by LEDs on the module. An audible alarm can be enabled to indicate an alarm or fault condition.

FRACTIONAL E1

The Fractional E1 Test Configuration allows the user to make the same selections as Full E1, except that the Frame Format must not be Unframed. With fractional E1, the bandwidth available for user data is determined by the number of time slots leased. The time slots not containing data will contain the idle code.

When in the Fractional E1 Configuration, the user is allowed to select which time slots will contain data and which time slots will contain the idle code within a transmitted frame.

The same time slots selected as DATA are analyzed by the receiver for the selected test pattern. Although there are 32 dip switches, representing the 32 time slots of a frame, the Time Slot 0 switch has no effect because the frame alignment signal is always in TS0. The Time Slot 16 switch only has an effect when the framing is CCS. When the framing is CAS, the TS16 switch has no effect because the multiframe alignment signal is in TS16.

The 32 Active Time Slot LEDs provide a visual display of the time slot switch selections, where the respective time slot LED is "on" for DATA and "off" for an IDLE code. The time slots which should contain the frame and multiframe alignment signals (TS0 and TS16) are indicated by their respective time slot LEDs being "off."

The pattern selected by the base unit is transmitted serially in the selected DATA time slot. and the IDLE code is transmitted in each of the other time slots. The receiver drops the selected DATA time slot from the received frames and sends the data to the base unit for pattern analysis at the effective bandwidth rate. The overall E1 frame is analyzed by the interface for errors, as well as, alarm and fault conditions.

ACTIVE TS DETECT – The Active Time Slot Detect Test Configuration selection provides the user the ability to determine which channels of a fractional E1 link are being utilized for data transmission and which channels are idle. The same Full E1 setup selections are allowed, except that the signal must be framed. In the Active TS Detect Configuration, the receiver monitors each time slot of a framed E1 signal for the idle code. The 32 Time Slot LEDs will inform the user of time slot content.

If a time slot contains the idle code, its respective LED will be "off" and if it contains data, it respective LED will be "on" if the framing is CAS, indicating that TS16 is used for the multiframe alignment signal. The interface transmitter continuously transmits idle characters in TS1-TS15 and TS17-TS31 while in this mode, and if looped back to its receiver, their respective Time Slot LEDs would be "off." The status of TS16 would depend upon the framing selection.

The E1/Fractional E1 Interface Module plugs into the Model 76B Bit Error Rate Test Set and provides the Model 76B with the ability to perform error rate testing on full E1 (2.048 MHz) circuits, as well as, fractional E1 circuits. It also allows the user to monitor an incoming E1 signal and determine which time slots of the framed signal contain data and which contain idle characters.

The interface module provides selections for the Test Configuration, Line Code, Frame Format, CRC-4, Tx Timing Source, Impedance, Rx Input Z, Individual time Slot content, and Audible Enable. In the Fractional E1 mode, TS1-TS15 and TS17-31 are always selectable to be either data or the idle code. TS16 is also available for Data/Idle characters when the framing format is CCS. The test set provides the selected data pattern at the effective rate of the bandwidth required by the number of time slots selected as data.

The interface transmits the framed 2.048 MHz E1 signal, which consists of the selected data time slots containing the test pattern and the time slots with the idle code inserted. The receiver removes the test pattern from the selected Data time slots and performs an error rate test on it.

Thirty-two Time Slot LEDs provide an indication of either the time slots currently being used to transmit and/or receive a test pattern or the Data/Idle status of the channels in a received framed E1 signal. Seven LEDs provide a visual indication of No Frame Alignment (FA), No Multiframe Alignment (MFA), Loss of Signal, AIS (64K), AIS (2M), Remote Alarm, and Remote Multiframe Alarm. An audio tone occurs at half second intervals, if enabled, when any of the fault LEDs are lit.

E1/FRACTIONAL E1 FRONT PANEL CONTROLS AND INDICATORS

E1/FRACTIONAL E1 CONNECTORS – The physical interface connection to the E1 circuit is provided by BNC connectors.

IMPEDANCE – This two-position slide switch changes the impedance of both the transmitter and receiver. In the 75 ohm position, the impedance is 75 ohms and in the 120 ohm position, the impedance is 120 ohms.

Rx Z – This 2-position slide switch determines whether the receiver input impedance is the value selected by the Impedance switch (TERMINATE) or an impedance greater than 1K ohms (BRIDGE).

TEST CONFIGURATION – This 3-position slide switch allows the user the ability to transmit and receive/analyze a FULL E1 signal, a FRACTIONAL E1 signal with user-selectable data time slots or in the ACTIVE TS DETECT position, to automatically detect which received E1 time slots contain data and which contain the idle character.

FRAME FORMAT – This 3-position slide switch allows the selection of either unframed data, CCS (Common Channel Signaling) frame format or CAS (Channel Associated Signaling) multiframe format. In the Unframed format, data is transmitted as a continuous bit stream without the addition of framing bits. In the framed modes, a bit pattern, embedded within the data stream, structures the signal into time slots for proper data retrieval.

The CCS or Common Channel Signaling format utilizes time slot 0 for frame alignment but has no multiframe alignment. Time slot 16 will be used for pattern data when Full E1, or selectable as Data or the Idle code when Fractional E1.

The CAS or Common Associated Signaling format utilizes time slot 0 for frame alignment and time slot 16 for multiframe alignment.

Tx TIMING – This 3-position slide switch allows the transmit timing source to be selectable between either the INTERNAL 2.048 MHz. crystal oscillator, the RECOVERED clock, or an EXTERNAL clock. In systems slaved to a central timing source, the user must select RECOVERED Tx Timing or timing slips will cause errors and sync losses. If a central timing source is not used, then a selection of either INTERNAL or EXTERNAL may be used.

The RECOVERED selection causes the recovered clock to be passed through a jitter attenuator to reduce any jitter produced by the pulsed-tank circuit clock recovery of the interface module receiver. The de-jittered clock is used as the timing source for the test set's transmit data. In the EXTERNAL position, no de-jitter circuitry is used and the quality and tolerance of the clock is dependent upon the external clock source.

LINE CODE – This 2-position slide switch determines the line code to be used by the module. In the AMI position, the signal is a standard alternate mark inversion coding scheme with no zero suppression. In the HDB3 position, zero suppression is accomplished with HDB3 (high density bipolar order of 3) encoding.

CRC-4 – This 2-position slide switch allows the user to enable or disable the CRC-4 (CYCLIC REDUNDANCY CHECK-4) multiframe format. The CRC-4 format utilizes bit 1 of time slot 0 for CRC-4 alignment. This switch is ignored whenever the Frame Format selection is Unframed.

ACTIVE TIME SLOTS (LEDs) – Thirty-two green LEDs, labeled ACTIVE TIME SLOTS, are provided to inform the user as to which time slots of the frame contain data and which contain idle codes.

Whenever unframed full E1 is selected, all of the Active Time Slot LEDs will be "on," indicating that all time slots are being used for the selected test pattern. If CCS framing is selected, the TS0 LED will go "off," indicating that time slot 0 is being used for the frame alignment signal and not the selected test pattern. If CAS framing is selected, the TS16 LED will also be "off," indicating that time

slot 16 is being used for the multiframe alignment signal and not the selected test pattern.

In the Fractional E1 test configuration, each Time Slot LED will indicate whether its respective Time Slot Select switch is in the DATA position (LED "on"). The TS0 LED will always be "off." The TS16 LED will be "off" if the framing is CAS, otherwise, it will indicate if Data or Idle is selected for time slot 16.

When the Active TX Detect test configuration is selected, the receiver will examine each time slot for the Idle code. If the Idle code is detected, the test set turns "off" the LED associated with that time slot. If the Idle code is not detected in a time slot, the test set turns "on" the LED associated with the time slot. The TS0 LED will be "on" and the TS16 LED will also be "on," if CAS framing is selected.

TIME SLOT SELECT – Thirty-two dip switches, labeled TIME SLOT SELECT, are used in the Fractional E1 test configuration to select which time slots are to contain the test pattern data and which are to contain idle characters for transmission within the E1 frame. The receiver will only look at the time slots selected as DATA for analysis of the received data. Each time slot switch is numbered according to its respective time slot position within the frame. Each switch has two selectable positions labeled DATA and IDLE.

When a time slot select switch is "on" (DATA position), the appropriate active time slot LED will light and 8 bits of the selected transmit data pattern are placed in that time slot of each frame. When a switch is "off" (IDLE), the LED associated with that channel will be "off" and the idle code (11010101) will be transmitted in that channel of each frame.

Time slot 0 switch has no effect because the frame alignment signal is located there. Time slot 16 is only available for selection when the framing is CCS. When the framing selection is CAS, time slot 16 contains the multiframe alignment signal, therefore, the TS16 switch position is ignored.

NO FA LED – This red LED indicates that the test set's receiver has either lost or never achieved Frame Alignment.

NO MFA LED – This red LED indicates that the test set's receiver has either lost or has never achieved Multiframe Alignment.

LOSS OF SIGNAL LED – This red LED indicates that the receiver has received at least 32 consecutive zeros and declared a loss of signal condition.

AIS (64K) LED – This red LED turns "on" when the contents of time slot 16 have been an all "ones" signal for at least two consecutive frames.

AIS (2 M) LED – This red LED turns "on" when less than 3 bit positions in the last FAS and non-FAS frames received are a 0.

REMOTE ALARM LED – The Remote Alarm LED indicates that a remote alarm has been detected and that remote frame alignment has been lost. It is declared when bit 3 of time slot 0 in non-FAS frames is a "1" for three consecutive non-FAS frames.

REMOTE MF ALARM – The Remote MF Alarm LED indicates that remote alarm has been detected and that remote multiframe alignment has been lost. It is declared whenever bit 6 of time slot 16 in frame 0 is a "1" for three consecutive multiframes.

AUDIBLE ALARM – When enabled by the AUDIBLE On/Off switch, this speaker generates an audible tone whenever a fault or alarm is detected. The tone will turn "on" and "off" at a one second rate and will continue as long as any alarm conditions exists.

AUDIBLE ON/OFF – This two-position slide switch enables or disables the Audible Alarm.

EXTERNAL CLOCK IN – This BNC connector, in conjunction with the Tx Timing switch, provides the user with the ability to transmit the test set patterns using an external TTL compatible timing source.

E1/FRACTIONAL E1 (E1/FE1) INTERFACE MODULE SUMMARY

Interface Specifications	G.703, G.704, G.732
Framing Format	Unframed, CCS, CAS
Line Code	AMI or HDB3
Rx Impedance	75 ohms, 120 ohms, Bridge (> 1 K ohms)
Test Configurations	Full E1, Fractional E1, Active TS Detect
Tx Timing	Internal (2.048 MHz crystal) Recovered (from receive data) External (BNC TTL input)
Time Slot LEDs	Thirty-two (32) green LEDs indicate which of the time slots contain data or idle characters
TS Select Switches	Thirty-tow (32) dip switches select the time slot contents (Data or Idle)
Fault & Alarm LEDs	NO FA LED NO MFA LED LOSS OF SIGNAL LED AIS (64 K) LED AIS (2 M) LED REMOTE ALARM LED

	REMOTE MF ALARM LED
Audible Alarm	Activated for alarm and fault conditions, memory failure, illegal switch settings. Audible ON/OFF switch selectable
Speed	2.048 Mbps

3.3 SUMMARY OF OTHER MODEL 76B INTERFACE MODULES

RS-232-C

Interface Specification	RS-232-C, CCITT V.24
Monitor LEDs	TD, RD, RTS, CTS, DTR, DSR, TCE, DCD, TC, RC
Interface Connector	25 pin, male, D-type. Cable included
Speed	Up to 64 Kbps

V.35

Interface Specification	CCITT V.35
Interface Signal Control	LT (Local Test)
Monitor LEDs	SD, RD, RTS, CTS, DTR, DSR, SCTE, RLSD, LT, SCT, SCR
Interface Connector	34 pin, male, Winchester-type. Cable included.
Speed	Up to 2.048 Mbps

RS-449-B (balanced) with EIA 530 capability

Interface Specification	RS-449, RS-422, RS-423
Interface Signal Control	LL (Local Loopback), RL (Remote Loopback)
Monitor LEDs	SD, RD, RS, CS, TR, DM, TT, RR, LL, ST, RL, RT
Interface Connector	37 pin, male, D-type. Cable included
RS-449 to EIA 530	Cable adapter with 25 pin, male, D-type connector
Speed	Up to 10 Mbps

MIL188-114

Interface Specification	MIL 188-114
Monitor LEDs	SD, RD, RS, CS, TR, DM, RR, ST, RT, TT
Interface Connector	37 Pin, male, D-type. Cable included
Speed	Up to 10 Mbps

DS1/T1

Interface Specification	AT& T Pub. 62411, CB144, Issue 1
Framing Format	Unframed, D4 (F_t), D4 (F_t, F_s), ESF

Line Code	AMI or B8ZS
Tx Timing	Internal 1.544 MHz, Loop (recovered receive clock)
Rx Impedance	Terminate (100 ohms), Bridge (>1K ohms)
Alarms	Loss of Carrier, Loss of Local and Remote Frame Sync (Red and Yellow Alarms)
Monitor LEDs	SD and RD
Interface Connector	15 pin, female, D-type with 310, and Bantam adapters available. Cable included
Speed	1.544 Mbps

	G.703
Interface Specification	G.703
64 Kbps Co-directional	Internal or recovered clock, 120 ohm balanced,
Interface Connector	25 pin, male, D-type. Cable included
2.048 Mbps HDB3	Internal or recovered clock, 75 ohm co-axial connector
8.448 Mbps HDB3	Internal Tx clock, recovered Rx clock. 75 ohm co-axial connector

4.0 MODEL 45 PORTABLE BATTERY PACK

The Model 45 Rechargeable Battery Pack can provide portable battery power for up to 18 hours for the hand-held IDS Model 76B Test Set. This light-weight battery pack is contained in a small blue canvas carrying case complete with shoulder strap and two side pockets. Some features of the Model 45 are as follows:

- Provides battery power for the IDS Model 76B Hand-held Test Set
- Provides up to 18 hours of operation before recharging
- Durable light-weight aluminum enclosure
- Comes complete with canvas carrying case with shoulder strap and side pockets
- Automatically turns off when the test set power switch is turned off
- Automatic cutoff prevents damage to batteries

4.1 BATTERY LIFE

The chart below lists the operating time of the Model 45 Battery Pack before it must be recharged when driving the IDS Model 76B Hand-held Test Set. The battery life is dependent on the interface module being used with the Model 76B Hand-held Test Set. (The chart also applies to the IDS Model 76B Portable

Test Set which has a built-in rechargeable battery.) The battery will fully recharge in 6 hours.

INTERFACE	HOURS	INTERFACE	HOURS
RS-232	18	G.703 (8.448 Mbps)	10
DS1/T1	16	RS-449-B	9
MIL188-114	15	E1/FE1	9
G.703 (2.048 Mb/s)	11	G.703 (64 Kb/s)	9
T1/FT1 (1.554 Mb/s)	10	V.35	6

4.2 MODEL 45 FRONT PANEL CONTROLS AND INDICATORS

A line drawing of the Model 45 front panel is shown in Figure 4.2. The description of the front panel indicators and controls follows.

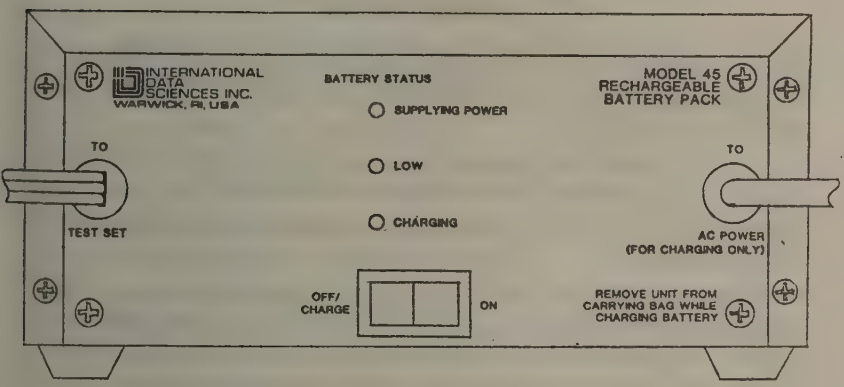


Figure 4.2 MODEL 45 FRONT PANEL

OPERATION OF THE MODEL 45

To supply battery power to the IDS Model 76B Hand-held Test Set, simply plug the attached cable labeled TO TEST SET into the test set power input plug and set the front panel power switch to the ON position.

To charge the battery, set the power switch to the OFF/CHARGE position and plug the attached AC power cord into an AC wall outlet. The AC cord is labeled either 115VAC or 230VAC.

The LED labeled SUPPLYING POWER will light whenever the test set is drawing current from the Model 45 battery pack. Turning off power on the test

set front panel will cause this LED to extinguish. The other two LEDs indicate when the battery is low or when it is being charged.

BATTERY STATUS INDICATORS

SUPPLYING POWER – This green LED is on whenever the Model 45 is supplying power to the M76B attached to the TO TEST SET output cord.

LOW – This red LED lights whenever the output battery voltage of the Model 45 falls below +11.5 volts. There is about 1/2 hour of battery life remaining after this LED first turns on.

To conserve remaining battery power, this LED will not light unless the Model 76B power switch is in the ON position and power is being drawn from the Model 45.

CHARGING – This red LED indicates that the Model 45 is in the process of charging its batteries. This LED stays on during recharging and then slowly cycles on and off once the batteries have reached their fully charged state.

POWER SWITCH

This 2-position rocker switch is used to control the operation of the Model 45, either charging the batteries (OFF/CHARGE) or supplying power to the attached Model 76B (ON).

ON – When the power switch is in the ON position, the Model 45 will supply power to the Model 76B attached to the TO TEST SET output cord. The Model 45 automatically stops supplying power when the battery voltage drops below cutoff.

OFF/CHARGE – With the power switch in the OFF/CHARGE position, the Model 45 does not supply any power to the attached Model 76B, and the LEDs labeled SUPPLYING POWER and LOW are disabled. Instead, the Model 45's batteries are charged if the unit is connected to an AC power source. Batteries that have been drained to the cutoff level require 6 hours to be fully recharged. The CHARGING LED, which is on during the charging cycle, slowly alternates between on and off once the batteries reach the fully charged state.

POWER CORDS

TO TEST SET – This 6-foot cord, located on the left side of the Model 45, is identical to the output cord of the Model 26 and 27 AC/DC converter. It is used for supplying DC power to the IDS Model 76B.

BATTERY CUTOFF – Substantially shuts down battery output power when batteries drain to below +10.5V.

TO AC POWER – This 6-foot cord labeled TO AC POWER, located on the right side of the unit, is used for connecting the 45 to an AC power source. It only needs to be connected when charging the batteries.

4.3 MODEL 76B BATTERY-POWERED PORTABLE

The Model 76B Battery-powered Portable contains an internal rechargeable battery. The unit can be considered a benchtop with a built-in Model 45 Battery Pack. The life of the internal battery is dependent upon plug-in modules and is identical to the chart shown in section 4.1. The unit is identical to a Model 76B Benchtop, except that it is smaller. The Model 76B Battery-powered Portable has a front panel that is identical to the left and right front panels of the Model 76B Hand-held Test Set. It has a handle on the top of the unit and rubber feet on the bottom and rear. A rear panel contains storage for two interface modules. All power and battery-charging controls are located on the rear panel. The battery-status LEDs are located on the front panel.

CONTROLS AND INDICATORS

POWER – A three-position power switch on the rear panel controls the power to the 76B test set. The three positions are labeled as follows: OFF – removes power from the test set and allows the battery to charge if the AC cord is plugged into the AC wall outlet. AC – provides power to the test set from the AC wall outlet and also charges the battery. BATTERY – test set is powered from the internal battery. A detachable AC cord is provided.

BATTERY STATUS – Three LEDs on the front panel indicate the status of the internal battery. SUPPLYING POWER – a green LED indicating that the internal battery is supplying power to the test set. LOW – a red LED indicating the internal battery needs to be recharged. CHARGING – a red LED indicating the internal battery is being recharged.

5.0 MODEL 76B PRINTER

The Model 76B printer and frequency meter is a stand-alone intelligent device for use with the Model 76B. In addition, an external RS-232-C port is provided, enabling the IDS Model 76B printer to be used in non-intelligent mode (i.e., print dump only) from other devices (i.e., testers, modems, multiplexers, etc.)

Principal features are as follows:

- Recording of bit error rate and sync loss data from the Model 76B, with time stamp
- Calculation and recording of G.821 parameters
- Print modes of 1 minute (abbreviated print), 1 hour or 24 hours (full print)
- Selected print thresholds of NONE, 10^{-2}, 10^{-3}, 10^{-4}

- Continual monitoring of transmit and receive clocks

Maximum and minimum values of clock frequency are recorded in full print modes.

5.1 FRONT PANEL CONTROLS AND INDICATORS

SELECT AND SET SWITCHES FOR TIME/DATE – It will not normally be necessary to use these switches except when changing from/to summer or winter time. The real time clock module is battery backed up with at least 10 years of non-volatile operation.

1) To Set Time/Date: Power on printer, wait for self-test to complete and the printer to automatically go to the ON-LINE mode.

2) Set Time/Frequency Time: (NOTE: Report rate switch should not be in the EXT position as only Frequency is displayed in this mode.)

Hold the SELECT button down for 4 seconds.

The message - ADJUST CLOCK - SET YEAR - 19XX will appear (XX being any numbers).

3) Scroll through numbers with the SET button to select the year. (Holding the SECONDS button will cause automatic scroll).

4) Push the SELECT button, set MONTH as above, set DAY, HOURS, MINUTES and SECONDS in the same way. On completion, a typical display would be: TUES JULY 26 92 at 17 13 25

RESET SWITCH – Pushing the RESET switch will set all counters in the printer to zero, but will not effect the display of the Model 76B. The correct procedure to begin a test is to press both the printer RESET and the Model 76B RESET concurrently and then the PRINT switch to begin the logging. Note that reset and on-line logging are automatically initiated following power on. It is important to note that because of the initial stabilizing time of the frequency counter, the RESET switch should be depressed about 5 minutes after initial power on. This ensures that subsequent printouts of TX and RX clock frequencies will be accurate to 6 parts per million.

REPORT RATE SWITCH – This is a 4-position switch selecting print periods of 1 minute, 1 hour, or 24 hours. An EXT position enables the auxiliary RS-232C port, when it is required, to record data from a device other than the 76B. **WARNING:** When used in this mode, the Model 76B should not be plugged in at the same time.

PRINT SWITCH – The PRINT switch is used to obtain, in 1 hour or 24 hour modes, a full manual printout of BERT statistics. This function is inoperative in the 1 minute or EXT positions of the REPORT RATE switch.

THRESHOLD SWITCH – A feature of the Model 76B printer is that in the 1 hour and 24 hour modes certain automatic events will be printed such as error bursts and sync losses.

To avoid very long printouts on degraded circuits, the THRESHOLD switch enables automatic printouts above selected error rates of 10^{-2}, 10^{-3}, and 10^{-4}. In the NONE position, automatic printouts will occur for all errors. The NONE position will thus be used on relatively quiet circuits.

TIME/FREQUENCY – In the TIME position, date/time information will be displayed including real time in hours, minutes and seconds. In FREQ position, the frequency of both transmit and receive clocks is displayed in real time, to an accuracy of +/- 6 parts per million. This is also operative in EXT mode, i.e., clocks present on pins 15 and 17 of the RS-232C port will be monitored.

LCD – This is a contrast control for the 32 character display.

POWER ON INDICATOR – This is situated at the bottom left of the front panel.

5.2 PRINTER REAR PANEL

The following controls are located on the rear panel of the IDS Printer.

1) A voltage selector switch for 115V or 230V AC operation.

2) A power on switch with fuse.

3) A 37-pin connector connection by ribbon cable to Model 76B.

4) A 25-pin connector for use in EXT mode.

5) A baud rate select switch which enables the printer to receive data from an external asynchronous device at selected rates of 300, 600, 1200 and 2400 bits. In all cases data is 7 bit ASCII with even parity and 1 stop bit.

5.3 PRINT FORMAT

Three print formats are available: Short, Full, and Automatic. Examples of each follow.

SHORT PRINT FORMAT (1 minute mode only)

E.F.S. % is Error Free Seconds divided by elapsed seconds x 100. Bit error rate (BERT) is bit errors divided by total bits sent. A typical short format printout follows.

1 MINUTE	26-7-92 11-53-54
E.F.S. %	98.75
TOTAL SYNC LOSS	00.0
BIT ERROR RATE	4.19 E-9
BITS IN ERROR	3.00E 0
BITS SENT	7.14E 8

FULL PRINT FORMAT (1 hour, 24 hours, and manual print modes)

G.821 parameters are recorded in accordance with the CCITT recommendations. Bipolar violations and A.I.S. alarm are active in the 2.048M G.703 test mode. An example of a full print format follows.

1 HOUR REPORT	26-7-92 20-2-39
ELAPSED SECONDS	3.60E 3
ERROR FREE SECONDS	3.59E 3
ERRD SECS (G821) %	0.25
ERRORED SECS	9.00E 0
S.E.S. (G821) %	0.22
SEV ERRORED SECS	8.00E 0
DEG MINS (G821) %	1.66
DEGRADED MINUTES	1.00E 0
BIPOLAR VIOLATIONS	NOT ENABLED
A.I.S. ALARM	NOT ENABLED
RXC RATE MAX/MIN	2048016
TXC RATE MAX/MIN	2048016
E.F.S. %	99.75
TOTAL SYNC LOSS	030
BIT ERROR RATE	5.43E -4
BITS IN ERROR	4.00E 6
BITS SENT	7.38E 9

AUTOMATIC PRINTOUT

In the 1 hour or 24 hour modes, a typical printout is as follows:

THRESHOLD EXCEEDED	26-7-92 11-57-20
TOTAL SYNC LOSS	002
BIT ERROR RATE	7.12E -2
BITS IN ERROR	1.57E 6
BITS SENT	2.20E 7

6.0 MODEL 76B APPLICATIONS

The versatility of the Model 76B provides the user with the basic testing functions required to effectively troubleshoot and isolate faulty or marginal network equipment. Through end-to-end, point-to-point and loopback testing, the Model 76B can isolate the problem whether the network is synchronous, asynchronous, or a digital network such as T1.

END-TO-END AND POINT-TO-POINT TESTING

The most basic test of a network is an end-to-end test. (See Figure 6.0.1) A bit error rate, block error rate or error-free seconds test is performed to determine if the fault lies with the modems and metallic lines or with the DTEs. The end-to-end test sectionalizes the problem area but does not eliminate all properly functioning equipment. It has the added disadvantage of requiring a person and test set at each end of the network.

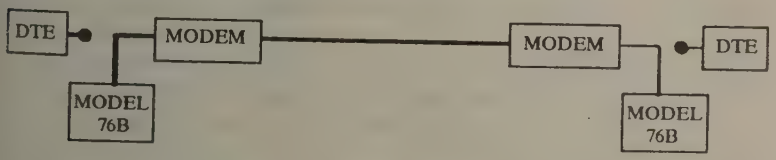


Figure 6.0.1 END-TO-END TESTING

Point-to-point testing is a variation of end-to-end testing. Whereas end-to-end testing encompasses the entire network, point-to-point testing is between given points within a network. Figure 6.0.2 shows a network which could be sectionalized by point-to-point testing to isolate the fault to a specific section. An end-to-end test would be from point A to point F. An error rate test can be performed between points A and B, as well as points C and D, to verify the operational status of those links. If they are good, the multiplexer channel can be verified by performing an error rate test between points E and F. Further

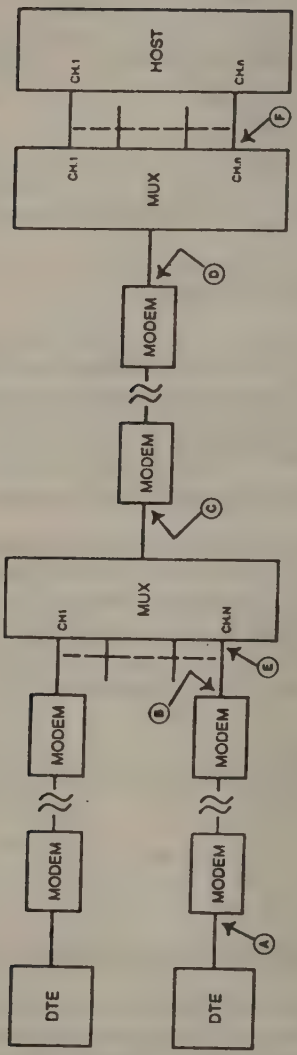


Figure 6.0.2 POINT-TO-POINT TESTING

isolation would require loopback testing, line switching, or equipment exchange.

LOOPBACK TESTING

Loopback testing, when applicable, provides the easiest and quickest method to isolate a failure. (See Figure 6.0.3)

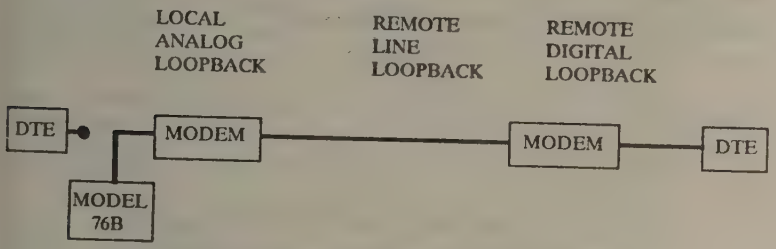


Figure 6.0.3 FAILURE ISOLATION USING LOOPBACKS

Testing a network capable of various types of loopbacks allows all testing and failure isolation to be done from a single location. A good analog loopback test eliminates the local modem and metallic lines, and a good remote digital loopback indicates that the problem is probably the DTE, with a slight chance that the remote modem has a problem in circuitry not utilized during the loopback.

TESTING DIGITAL NETWORKS

The Model 76B is also capable of testing and troubleshooting in a digital network environment. Figure 6.0.4 shows an end-to-end test setup where the test set at each end has an appropriate interface module (V.35 or RS-449B) plugged in. Although the figure shows the test sets connected to DSUs, the connection points could be high speed modems connected to the DSUs or high speed modems with integral DSUs. An end-to-end bit error rate test would be used to verify network operation and that the specified error rate is met. Figure 6.0.5 shows a test set with a V.35 or RS-449-B interface connected to a DSU or modem at one end of the network and a test set with a DS1/T1 interface connected to a DSU at the other end. This test would allow the verification of a faulty DSU or modem. Figure 6.0.6 shows a point-to-point test utilizing DS1/T1 interfaces connected to the CSUs.

Figure 6.0.7 shows loopback testing on a T1 network. The Model 76B hand-held or benchtop with a DS1/T1 interface can generate LOOP UP and LOOP DOWN codes (per Pub. 62411) to activate a loopback at the far end CSU. Testing can then be performed from a single location with a single test set.

The unit can also monitor a DS1 line with the DS1/T1 interface. If the test set is selected for the DS1 ERR mode, bipolar violations, framing errors and CRC-6 (EFS only) errors may be monitored. The display, in this mode, also maintains the percentage of error-free seconds based upon the errors displayed. Figure 6.0.8 shows a typical test set up for in-service monitoring.

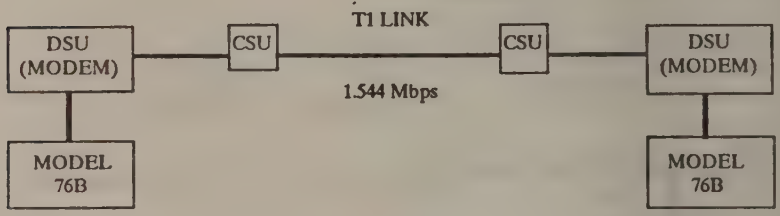


Figure 6.0.4 T1 END-TO-END TESTING

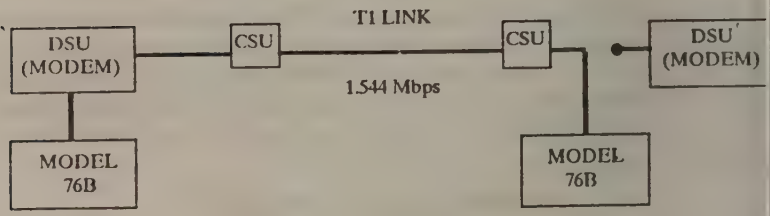


Figure 6.0.5 NEAR-END DSU TO FAR-END CSU TESTING

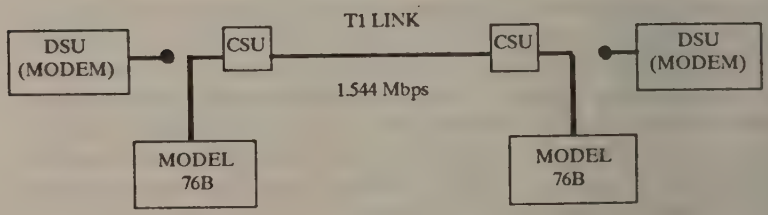


Figure 6.0.6 CSU-TO-CSU TESTING

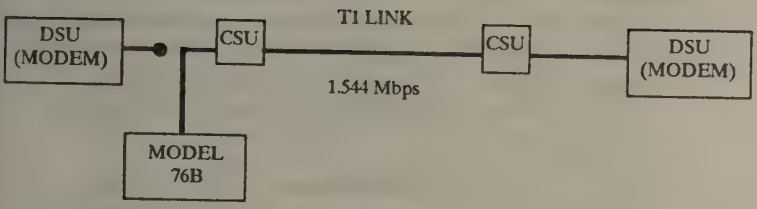


Figure 6.0.7 LOOPBACK TESTING WITH A CSU

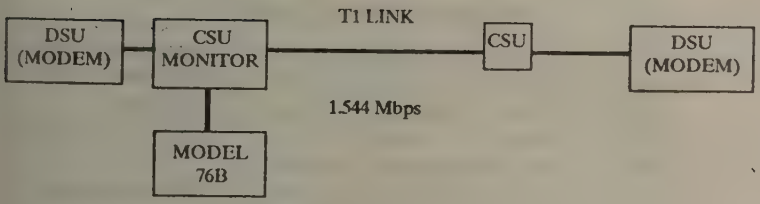


Figure 6.0.8 IN-SERVICE MONITORING

STRESS TESTING

The Model 76B and Model 76B Benchtop provide the user with two patterns designed to stress the ones density requirements of T1 networks. The 1 in 8 pattern provides a repetitive byte of seven "0s" and one "1" for stressing systems which limit the maximum number of consecutive zeroes to 7, such as those employing B8ZS coding.

The 3 in 24 pattern provides a "1s" density of 12.5% and a maximum of 15 consecutive zeroes for stressing networks which do not utilize zero code suppression. In order to prevent the transmission of a yellow alarm when D4 framing is selected, both patterns are frame locked to insure a "1" in bit 2 of each channel.

7.0 SPECIFICATIONS

MODEL 76B

76B Hand-Held

Enclosure	Durable, plastic-molded, Scratch-Resistant Lexan Panel
Dimensions	8.1" D x 6.9" W x 2.4" H (20.6 cm x 17.5 cm x 6 cm)
Weight	3 lbs. (1.4 kg) excluding Power Supply and Interface Module
Battery Power	Model 45 Rechargeable Portable Battery Pack available
AC Power	115VAC ± 10%, @ 60 Hz. Model 26 wall-mounted
	230VAC ± 10%, @ 50 Hz. Model 27 wall-mounted

76B Benchtop

Enclosure	Lightweight aluminum, Scratch-Resistant Lexan Panel
Dimensions	8.6" D x 13.7" W x 7.6" H (22 cm x 34.8 cm x 19.3 cm)
Weight	7.5 lbs. (3.4 kg) not including Interface Module
Option	Rackmount Adapter 19" W x 8.75" H (48.3 cm x 22.2 cm)
AC Power	115VAC, ± 10% @ 50 Hz (AC cord attached)
	230VAC, ± 10% @ 50 Hz (AC cord attached)

76B Battery-Powered Portable

Enclosure	Lightweight aluminum, Scratch-Resistant Lexan Panel
Dimensions	7" D x 13.7" W x 7.6" H (17.8 cm x 34.8 cm x 19.3 cm)
Weight	11.8 lbs. (5.4 kg) not including Interface Module
Option	Rackmount Adapter 19" W x 8.75" H (48.3 cm x 22.2 cm)
Battery Power	Internal Rechargeable Battery
AC Power	115VAC, ± 10% @ 50 Hz (Plug-in AC cord included)
	230VAC, ± 10% @ 50 Hz (Plug-in AC cord included)
	Specify VAC when ordering

MODEL 45 PORTABLE BATTERY PACK

Enclosure	Light-weight aluminum, scratch-resistant panel
Dimensions	4.8"D x 6.8" W x 2.9"H (12 cm x 17 cm 7.4 cm)
Carrying Case	Blue canvas with shoulder strap. Zippered center section holds Model 45. Two zippered side pockets provide additional storage.
Carry Case Size	4.75" D x 9" W x 9" H (12 cm x 23 cm x 23 cm)
Weight	5 lbs. (2.3 kg) including Carrying Case
AC Power	115VAC, +/- 10% @ 60 Hz (Plug-in cord attached)
	230VAC, +/- 10% @ 50 Hz (Plug-in cord attached)
	Specify VAC when ordering. When charging, the Model 45 consumes approximately 13 watts.
DC Output	+12 VDC and -9 VDC

Battery	Two 6VDC rechargeable lead-acid, for a total capacity of 3.2 Amp-hours
Charging Time	Maximum 6 hours
Operating Temp	While charging, 32°F to 104°F (0°C to 40°C) While supplying power, 5°F to 122°F (-15°C to 50°C)
Storage Temp	5°F to 104°F (-15°C to 40°C)

ENVIRONMENTAL

Temperature	(Operating) 32°F to 122°F (0°C to 50°C) (Storage) -4°F to +158°F (-20°C to +70°C)
Humidity	90% maximum (non-condensing)

MODEL 76B PRINTER

Enclosure	High-impact plastic with metal front and rear panels
Assembly	40-column unit with plain paper roll
Ink Cassette	Approximately 250,000 character life
Installation	Paper roll and ink cassette are easily installed by opening the front door of the printer
Power	Power is from 115V, 60Hz or 230V, 50 Hz supplies, with voltage selector and power switch on the rear of the unit. When the printer is used with the Model 76B, the total system power is provided from the printer.

CAUTION: WHEN USING THE IDS PRINTER, DO NOT POWER THE MODEL 76B WITH THE AC ADAPTER. DAMAGE TO THE 76B MAY RESULT.

To interface with the Model 76B, a sub-module is employed between the Model 76B and interface module in use, with a short screen cable and connector to directly plug into the 37-pin D type connector on the rear of the interface.

A 25-way D type and associated baud rate select switch are located on the rear of the unit and can be used if it is required to print (or monitor clocks) from a device other than a Model 76B.

APPENDIX A
DATA RATE ACCURACIES

Desired Rate (bps)	Actual Rate (bps)	% Error
50	50	0.00
75	75	0.00
110	110.02	+0.02
300	300	0.00
600	600	0.00
1200	1200	0.00
2400	2400	0.00
3600	3600	0.00
4800	4800	0.00
7200	7200	0.00
9600	9600	0.00
14400	14400	0.00
19200	19200	0.00
38400	38400	0.00
56000	56000	0.00
64000	64000	0.00
256000	256000	0.00
1344000	1344000	0.00
1544400	1544400	0.00
2048000	2048000	0.00

APPENDIX B
FOX MESSAGES

The FOX messages used for the Model 76B are as follows:

BAUDOT (58 characters long, excluding pad and sync characters)
(Y P P)LCTHE QUICK BROWN FOX JUMPS OVER A LAZY DOG
UC0123456789CRLF
(6 0 0) LCTHE QUICK BROWN FOX JUMPS OVER A LAZY DOG
UC0123456789CRLF

IPARS (55 characters long, excluding pad and sync characters)
(V S1 S2) THE QUICK BROWN FOX JUMPS OVER A LAZY DOG
0123456789NL

ASCII (56 characters long, excluding sync characters)
(U SY SY) THE QUICK BROWN FOX JUMPS OVER A LAZY DOG
0123456789CRLF

( ) are the pad and sync characters that precede the FOX messages. They are not used as part of the error analysis.

If either 7 or 8 bit code levels are selected for the FOX message, the Model 76B responds to the reception of XON (DC1) and XOFF (DC3) characters. The reception of an XOFF character causes the transmitter to stop within several characters. The transmitter is re-enabled after the reception of an XON character. Neither XON or XOFF characters are included in the analysis of data.

APPENDIX C – ERROR MESSAGES

MESSAGE	CAUSE
INJECT ERROR SWITCH BAD	Switch Failure
INTERFACE MODULE MISSING	Interface module not plugged into the Model 76B
LOOP DOWN ABORTED	Either RTS was turned "OFF" or RESET/RESYNC was pressed during Loop Down attempt (DS1 only)
LOOP DOWN SWITCH FAILURE	Switch failure
LOOP NOT DISCONNECTED	Failure to disconnect loopback (DS1 only)
LOOP UP ABORTED	Either RTS was turned "OFF" or RESET/RESYNC was pressed during Loop Up attempt (DS1 only)
LOOP UP NOT COMPLETED	Failure to establish loopback (DS1 only)
LOOP UP SWITCH FAILURE	Switch failure
LOSS OF CARRIER	Local incoming signal failure (DS1 only)
MODULE INCOMPATIBLE WITH CURRENT MODE SELECTION	DSX ERR mode is only used for testing digital bipolar circuits
PROGRAM MEMORY FAILURE	Bad EPROM
RAM FAILURE	Bad RAM
RECEIVE CLOCK MISSING	Receive clock missing
RED ALARM, LOST LOCAL FRAME SYNC	Loss of local frame synchronization (DS1 only)
RESET/RESYNC SWITCH BAD	Switch Failure
THE FOX PATTERN REQUIRES A 5, 6, 7, or 8 CODE LEVEL	Improper switch setting
THE FOX PATTERN REQUIRES NORMAL TX DATA SELECTION	Illegal switch combination
YELLOW ALARM, LOST REMOTE FRAME SYNC	Loss of remote frame synchronization (DS1 only)

WARRANTY

All International Data Sciences, Inc., products are warranted against defects in material, workmanship, and component failure for one year from date of purchase unless noted otherwise. The Model 76 B comes with a Three (3) Year Warranty. All units repaired by IDS are warranted for 90 days following the repair service.

This warranty does not apply if the equipment has been damaged by accident, neglect, misuse, or causes other than ordinary use, or as a result of service or modification other than performed or authorized by IDS.

Prior to shipping your unit, contact IDS at 1-800-IDS-DATA for a Return Material Authorization (RMA) number.

All units returned to IDS under this warranty require prepaid transportation charges. The purchaser is also responsible for all transportation charges incurred in returning the repaired unit to the purchaser.

REPAIR SERVICE

Should your unit require repairs not covered by the original warranty, IDS will perform the repair at an hourly charge plus parts. Normal turn-around time is two weeks.

Prior to shipping your unit, contact IDS at 1-800-IDS-DATA for a Return Material Authorization (RMA) number. All units returned to IDS for repair will be accepted only if transportation charges are prepaid. The purchaser is responsible for all transportation charges incurred in the return of the repaired unit. Please include a purchase order.

Units for repair should be sent to International Data Sciences, Inc., 501 Jefferson Blvd., Warwick, RI 02886-1317, Attention: Repair Department.

For fast return, DHL is are recommended; otherwise, units will be returned via UPS. Clearly state the name of the person to whom the unit should be sent with your complete return address.

ORDERING INFORMATION

MODEL	DESCRIPTION
76B	Hand-Held T1/E1 Sync/Async BERT with small Carry Case (Bellcore CLEI Code T1PQ6BA1AA)
76B	Hand-Held T1/E1 Sync/Async BERT with large Carry Case
76B	Benchtop T1/E1 Sync/Async BERT
76B	Portable T1/E1 Sync/Async BERT with both AC and internal rechargeable battery power
45	Rechargeable Portable Battery Pack with Carry Case

Plug-in interface modules are not included with models listed above, but sold separately as options.

OPTIONS

DS1/T1 Interface Module with Cable (Bellcore CLEI Code T1PQ6BB1AA)
T1/Fractional T1 Interface Module with Cable
RS-232-C Interface Module with Cable
V.35 Interface Module with Cable
RS-449 Balanced Interface Module with Cable
RS-449 to EIA 530 Cable Adapter
MIL 188-114 Interface Module with Cable
G.703 (64 Kbps) Interface Module with Cable
G.703 (2.048 Mbps) Interface Module with Cable
G.703 (8.448 Mbps) Interface Module with Cable
E1/Fractional E1 Interface Module with Cable
Rackmount Adapter for Benchtop
Carry Case for 76B Hand-Held plus 5 Modules
Carry Case for 76B Portable plus 6 Modules
Printer for use with all Models of 76B

NOTES

NOTES

IDS PRODUCTS INCLUDE

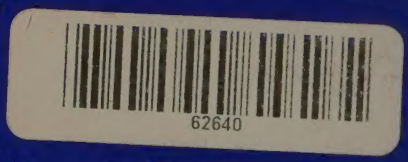
LAN AND VOICE CABLE TESTERS
BIT ERROR RATE TESTERS
T1 AND FRACTIONAL T1 TESTERS
BREAKOUT BOXES
ANALOG TEST SETS
ETHERNET/TOKEN RING MONITORS
WAN PROTOCOL ANALYZERS

FOR MORE INFORMATION
TELEPHONE TOLL FREE

1-800-IDS-DATA

(1-800-437-3282)

TEL: 401-737-9900
FAX: 401-737-9911



International Data Sciences, Inc.
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